

I claim:

1. Apparatus adapted to apply force, comprising:

(A) a housing having a housing interior;

(B) an elongated first extendable member and an elongated second extendable member respectively having first and second thread structures, said first and second extendable members telescopically disposed and movable with respect to one another and together telescopically received within said housing;

(C) a first threaded drive element having a first thread drive of a first thread pitch and operative to engage said first thread structure thereby to advance said first extendable member between an extended position and a retracted position relative to said housing;

(D) a second threaded drive element having a second thread drive of a second thread pitch and operative to engage said second thread structure thereby to advance said second extendable member between a contracted position wherein said second extendable member is telescopically received in said first extendable member and an expanded position wherein said second extendable member extends outwardly of said first extendable member; and

(E) a drive operative

(1) in a first mode to actuate said first and second threaded drive elements whereupon said first extendable member is advanced between the retracted position and the extended position and said second extendable member is advanced from the contracted position to the expanded position, and

(2) in a second mode to actuate said first and second threaded drive elements whereupon said first extendable member is advanced between the extended position and the retracted position and said second extendable member is advanced from the expanded position to the contracted position.

2. Apparatus according to claim 1 including a boot having a first boot end secured to said housing and a second boot end secured to said second extendable member.

3. Apparatus according to claim 1 including a foot member secured to an end of one of said first and second extendable members.

4. Apparatus according to claim 3 wherein said foot member is movable about at least two axes of motion.

5. Apparatus according to claim 1 including a detent assembly interfacing said first and second extendable members.

6. Apparatus according to claim 1 including a spline assembly including a shaft portion slideably engaging said second extendable member and a head portion interfacing with said housing and operative to resist rotation of said second extendable member relative to said housing.

7. Apparatus according to claim 6 wherein said head portion includes a head detent operative to permit rotational movement of said head relative to said housing upon a rotational force in excess of a selected magnitude.

8. Apparatus according to claim 1 wherein said drive is a reversible motor.

9. Apparatus according to claim 1 wherein said housing interior is generally cylindrical, said first extendable member sized and adapted to be telescopically received in the housing interior and including a first sidewall surrounding a first member interior, said first extendable member having a first sidewall having a cylindrical outer surface extending between inner and outer ends of said first extendable member with said first sidewall provided with first threads sized and adapted to engage the first thread drive.

10. Apparatus according to claim 9 wherein said second extendable member is sized and adapted to be telescopically received in the first member interior and including a second sidewall having a cylindrical outer surface provided with second threads sized and adapted to engage the second thread drive.

11. Apparatus according to claim 10 wherein said second threaded drive is disposed proximately to the outer end of said first extendable member whereby rotation of said first extendable member acts to advance said second extendable member between the expanded and contracted positions.

12. Apparatus according to claim 11 wherein said second threaded drive is a ball nut.

13. Apparatus according to claim 9 wherein said first threaded drive is a lift gear with internal threads having the first thread pitch.

14. Apparatus according to claim 1 wherein said first and second thread pitches are different from one another.

15. Apparatus according to claim 1 including an extension sensor operative to detect when said first extendable member is in the extended position.

16. Apparatus according to claim 1 including an contact sensor operative to detect when said first and second extendable members begin to apply a force on an object in excess of a threshold amount.

17. Apparatus according to claim 1 including a retraction sensor operative to detect when said first extendable member is in the retracted position.

18. Apparatus adapted to apply force, comprising:

(A) a housing including a housing sidewall surrounding a housing interior and first and second housing end portions;

(B) a lift gear disposed in said second housing end portion and including lift threads having a first thread pitch;

(C) an elongated first extendable member sized and adapted to be telescopically received in the housing interior and including a first sidewall surrounding a first member interior, said first sidewall having a cylindrical outer surface extending between first captured end and a first free end with said first sidewall provided with first threads sized and adapted to engage the lift threads on said lift gear;

(D) a threaded drive element disposed in the first member interior at a location proximate to the first free end thereof, said threaded drive element having a thread drive of a second thread pitch;

(E) an elongated second extendable member sized and adapted to be telescopically received in the first member interior, said second extendable member including a second sidewall having a cylindrical outer surface extending between a second captured end and a second free end with said second sidewall provided with second threads sized and adapted to engage the thread drive;

(F) a drive operative to rotate said lift gear whereupon:

(1) rotation of said lift gear in a first rotational direction acts to advance said first extendable member between a retracted position wherein said first extendable member is telescopically received in the housing interior and an extended position wherein said first extendable member extends longitudinally outwardly of said housing, and

(2) rotation of said lift gear in the first rotational direction when said first extendable member is in the extended position acts to rotate said first extendable member and said threaded drive element in the first rotational direction such that said second extendable member is advanced between a

contracted position wherein said second extendable member is telescopically received in the first member interior and an expanded position wherein said second extendable member extends longitudinally outwardly of said first extendable member, and

(3) rotation of said lift gear in a second rotational direction when said first extendable member is in the extended position acts to rotate said first extendable member and said threaded drive element in the second rotational direction such that said second extendable member is advanced from the expanded position toward the contracted position, and

(4) rotation of said lift gear in the second rotational direction when said second extendable member is in the contracted position acts to advance said first extendable member from the extended position toward the retracted position.

19. Apparatus according to claim 18 wherein said second extendable member has a keyway extending longitudinally therein, and including a spline assembly including a head portion disposed in the housing interior and adapted for sliding movement therein and a shaft portion slidably received in the keyway and operative to resist rotation of said second extendable member relative to said housing.

20. Apparatus according to claim 19 wherein said head portion includes at least one ball detent operative to permit of said head relative to said housing upon a rotational force in excess of a selected maximum.

21. Apparatus according to claim 20 wherein said housing sidewall has at least one longitudinally extending groove formed interiorly of said housing, said groove sized and adapted to engage said ball detent.

22. Apparatus according to claim 19 including a boot having a first boot end secured to said housing and a second boot end secured to the second free end of said second extendable member.

23. Apparatus according to claim 19 including a foot member secured to the second free end of said second extendable member.

24. Apparatus according to claim 23 including a boot having a first boot end secured to said housing and a second boot end secured to said foot member.

25. Apparatus according to claim 23 wherein said foot member is movable about at least two axes of motion.

26. Apparatus according to claim 19 including a detent assembly interfacing said first and second extendable members.

27. Apparatus according to claim 26 wherein said detent assembly acts with a first force resisting disengagement of said first and second extendable members for movement of said second extendable member from the contracted position to the expanded position and acts with a second force permitting re-engagement of said first and second extendable members when said second extendable member is moved from the expanded position to the contracted position, the first force being greater than the second force.

28. Apparatus according to claim 27 wherein said detent assembly includes a spring-biased detent element on one of said first and second extendable members and a spring-biased detent gate on another of said first and second extendable members.

29. Apparatus according to claim 18 wherein said threaded drive is a ball nut.

30. Apparatus according to claim 18 wherein said first and second thread pitches are different from one another.

31. Apparatus according to claim 30 wherein said second thread pitch has a greater number of thread per unit length than said first thread pitch.

32. Apparatus according to claim 18 including an extension sensor operative to detect when said first extendable member is in the extended position.

33. Apparatus according to claim 18 including an contact sensor operative to detect when said first and second extendable members begin to apply a force on an object in excess of a threshold amount.

34. Apparatus according to claim 18 wherein said drive includes a is a reversible motor and a drive gear engaging said lift gear.

35. Apparatus according to claim 34 wherein said drive includes a drive gear engaging said lift gear and including a drive gear sensor operative to monitor rotation of said drive gear.

36. Apparatus adapted to apply force between an object and a surface, comprising:

(A) a housing adapted to secure to the object and including a housing sidewall surrounding a housing interior;

(B) a lift gear supported by said housing for rotational movement and including lift threads having a first thread pitch;

(C) an elongated first extendable member sized and adapted to be telescopically received in the housing interior and including a first sidewall surrounding a first member interior, said first extendable member having a first sidewall having a cylindrical outer surface extending between inner and outer ends of said first extendable member with said first sidewall provided with first threads sized and adapted to engage the lift threads on said lift gear;

(D) a threaded drive element disposed in the first member interior at a location proximate to the outer end portion of said first extendable member, said threaded drive element being internally threaded with drive threads of a second thread pitch different from said first thread pitch;

(E) an elongated second extendable member sized and adapted to be telescopically received in the first member interior and having a keyway extending longitudinally therein, said second extendable member including a second sidewall having a cylindrical outer surface provided with second threads sized and adapted to engage the drive threads of said drive element;

(F) a spline assembly including a head portion disposed in the housing interior and adapted for sliding movement therein and a shaft portion slidably received in the keyway whereby said second extendable member and said shaft are prevented from relative rotation, said spline assembly operative to resist rotation of said second extendable member relative to said housing;

(G) a detent assembly interfacing said first and second extendable members;

(H) a drive including a motor and a drive gear operative to rotate said lift gear whereupon:

(1) rotation of said lift gear in a first rotational direction acts to advance said first extendable member between a first retracted position wherein said first extendable member is telescopically received in the housing interior and a first extended position wherein said first extendable member extends longitudinally outwardly of said housing, and

(2) rotation of said lift gear in the first rotational direction when said first extendable member is in the extended position acts to rotate said first extendable member and said drive element such that said second extendable

member is advanced between a second retracted position wherein said second extendable member is telescopically received in the first member interior and a second extended position wherein said second extendable member extends longitudinally outwardly of said first extendable member, and

(3) rotation of said lift gear in a second rotational direction when said first extendable member is in the first extended position acts to rotate said first extendable member and said drive element in the second rotational direction such that said second extendable member is advanced between the second extended position and the second retracted position, and

(4) rotation of said lift gear in the second rotational direction when said second extendable member is in the second retracted position acts to advance said first extendable member between the first extended position and the first retracted position.

37. Apparatus according to claim 36 including a drive gear sensor operative to monitor rotation of said drive gear.

38. Apparatus according to claim 36 including a contact sensor operative to detect when said first and second extendable members begin to apply a force on an object in excess of a threshold amount.

39. Apparatus according to claim 36 including a foot member secured to the second free end of said second extendable member and including a boot having a first boot end secured to said housing and a second boot end secured to said foot member.

40. Apparatus according to claim 36 wherein said detent assembly acts with a first force resisting disengagement of said first and second extendable members for movement of said second extendable member from the contracted position to the expanded position and acts with a second force permitting re-engagement of said first and second extendable members when said second extendable member is moved from the expanded position to the contracted position, the first force being greater than the second force.

41. Apparatus according to claim 40 wherein said detent assembly includes a spring-biased detent element on one of said first and second extendable members and a spring-biased detent gate on another of said first and second extendable members.

42. Lifting and leveling system adapted to support a vehicle relative to a support surface, comprising:

(A) at least one force applying apparatus including:

(1) a housing adapted to be secured to a vehicle and having a housing interior;

(2) an elongated first extendable member and an elongated second extendable member respectively having first and second thread structures, said first and second extendable members telescopically disposed and movable with respect to one another and together telescopically received within said housing;

(3) a first threaded drive element having a first thread drive of a first thread pitch and operative to engage said first thread structure thereby to advance said first extendable member between an extended position and a retracted position relative to said housing;

(4) a second threaded drive element having a second thread drive of a second thread pitch and operative to engage said second thread structure thereby to advance said second extendable member between a contracted positions wherein said second extendable member is telescopically received in said first extendable member and an expanded position wherein said second extendable member extends outwardly of said first extendable member;

(5) a drive operative

(a) in a first mode to actuate said first and second threaded drive elements whereupon said first extendable member is advanced between the retracted position and the extended position and said second extendable member is advanced from the contracted position toward the expanded position, and

(b) in a second mode to actuate said first and second threaded drive elements whereupon said first extendable member is advanced between the extended position and the retracted position and said second extendable member is advanced from the expanded position toward the contracted position;

(6) a first sensor operative to detect and generate a first signal when said first extendable member is in the extended position and a second

sensor operative to detect and generate a second signal when said second extendable member contacts one of the support surface or an object on the support surface; and

(B) a controller responsive to said first and second signals to control operation of said drive.

43. A method of applying a force between two locations, comprising:

(A) securing a housing at a first location wherein said housing telescopically receives a first extendable member and wherein said first extendable member telescopically receives a second extendable member;

(B) mechanically advancing said first extendable member at a first rate of extension from a retracted position within said housing to an extended position wherein said first and second extendable members extend axially outwardly of said housing; and

(C) mechanically advancing said second extendable member at a second rate from a contracted position within said first extendable member to an expanded position wherein said second extendable member extends axially outwardly of said first extendable member, the first rate being faster than the second rate.

44. A method according to claim 43 wherein the step of advancing said first extendable member is completed before beginning the step of advancing said second extendable member.

45. A method according to claim 43 including the step of monitoring the advancement of said second extendable member to determine if it makes contact with the second location.

46. A method according to claim 45 including the step of advancing said second extendable member for a pre-determined distance after said second extendable member makes contact with the second location.

47. A method according to claim 43 including the step of monitoring the advancement of said second extendable member for resistance that occurs before said second extendable member has advanced toward the expanded position for a pre-selected minimum distance and including the step of disabling advancement of said second extendable member should resistance be detected before reaching the pre-selected minimum distance.